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DECLARATION

The undersigned, Jan McLin Clayberg, having an office at 5316 Little Falls Road, Arlington, VA 22207-1522, hereby states that she is well acquainted with both the English and German languages and that the attached is a true translation to the best of her knowledge and ability of the specification and claims of international patent application PCT/EP 2005/054571 of AEBERHARD, B., entitled "HANDHELD POWER TOOL".

The undersigned further declares that the above statement is true; and further, that this statement was made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or document or any patent resulting therefrom.

Jan McLin Clayberg

HANDHELD POWER TOOL

Prior Art

The invention is based on a handheld power tool as generically defined by the preamble to claim 1.

Cordless drills or cordless screwdrivers are as a rule very compact in construction, and for stepping down the speed they have a single- or multi-stage planetary gear. Factors that argue for a planetary gear are its compact construction that can readily be integrated ergonomically into the handheld power tool, as well as its capability of transmitting high outputs with great sturdiness and running smoothness. One such cordless screwdriver is known from German Patent Disclosure DE 197 37 234 A1, for instance.

Advantages of the Invention

The invention is based on a handheld power tool having a motor, a planetary gear and a tool receptacle.

It is proposed that the handheld power tool has an air- moving means, located upstream of the motor, out of sight of the tool receptacle, for generating a cooling air stream that cools the planetary gear. As a result, while maintaining the structural design with a planetary gear, a gear with very high output and at the same time a long service life can be attained. By locating the air-moving means upstream of the motor, that is, in particular in the immediate vicinity of the planetary gear, effective cooling of the planetary gear can be achieved. The motor of the handheld power tool can additionally be cooled with a further air-moving means out of sight of the tool receptacle, downstream of the motor. In such a construction, by the provision of two air-moving means, air-carrying conduits around the motor can be dispensed with, and the ring gear can be made especially compact. The air-moving means for cooling the planetary gear can serve solely to cool the planetary gear, or it may for instance be provided for

additional cooling of the motor. The air-moving means is expediently a rotating air-moving means. Because of the compact design, the invention is especially well suited to a cordless handheld power tool, in particular a cordless screwdriver, cordless drill/screwdriver, or cordless impact drill/screwdriver.

If an autolock device is used that very quickly stops the engine from running on after the power supply has been interrupted by a user, then because of the sudden braking, very high forces may engage the high-speed air-moving means. An especially sturdy construction can be achieved by the designing the air-moving means as a fan wheel. Blades of the fan wheel can be joined together by a wheel - expediently solely on their radially outer end - thus lending the fan wheel high rigidity.

In an advantageous feature of the invention, the air- moving means is integrated with the planetary gear. As a result, the gear can be installed together with the air- moving means as a structural unit in the handheld power tool, thus lessening the effort and expense of assembly. Moreover, with this kind of disposition, the location where heat is produced, namely where the planet wheels are, is cooled especially effectively.

Expediently, the air-moving means is located between the motor and a gear stage of the planetary gear. As a result, it can be driven before a speed reduction and can thus be driven at high rotary speed.

An especially simple rotational slaving of the air- moving means can be attained if it is connected to a motor pinion in form-locking fashion. A form-locking geometry of the motor shaft for driving the air-moving means can be dispensed with, and in this way the motor shaft can be designed economically. The form lock can be produced especially simply if the teeth of the motor pinion mesh with a corresponding counterpart shape of the air-moving means.

Stable concentricity of the air-moving means can be attained if the air-moving means is braced on the motor shaft. The rotational slaving is advantageously achieved here via the form lock with the motor pinion and the stability of

concentricity is achieved by the direct bracing on the motor shaft. Thus in a simple way, simple assembly, with structural units of the handheld power tool that are economical to produce, and with an air-moving means that runs in a stable way, can all be attained.

In a further feature of the invention, it is proposed that the air-moving means is intended for generating a cooling air stream through the planetary gear. As a result, heat produced in the planetary gear can be especially effectively dissipated from the planetary gear. The planetary gear expediently includes a housing, which has at least one opening upstream and one opening downstream of the inner planetary gear components. The directions "upstream" and "downstream" refer to a view looking in the direction away from the tool receptacle.

It is furthermore proposed that the handheld power tool has a housing, with at least one first and second ventilation opening, and a ventilation conduit which extends continuously from the first ventilation opening through the planetary gear to the second ventilation opening. The housing is advantageously an outer housing, so that air from outside the handheld power tool can flow through the planetary gear. The ventilation conduit expediently experiences a flow through it in one direction during operation of the handheld power tool. Especially good heat dissipation from the planetary gear can be achieved if the first and second ventilation openings are located upstream and downstream, respectively, of at least one element of the planetary gear.

Good cooling of the planet wheels can be attained if the planet wheels are supported on a retaining means which has openings, extending in the axial direction, in a radial region of the planet wheels. These openings are for instance next to the planet wheels in the circumferential direction.

By means of a ventilation conduit that extends continuously from a coupling region of the handheld power tool to the motor, the planetary gear can experience an especially complete flow through it, and heat can be especially well dissipated.

A high cooling output of a gear wheel of the planetary gear can be achieved if

the air-moving means is located in the immediate vicinity of the gear wheel. The gear wheel is for instance a planet wheel. The immediacy is preserved if a narrow air gap, for assuring a difference in motion, remains between the gear wheel and the air-moving means. However, this air gap is free of components.

A cordless screwdriver is typically used in both directions of rotation. Cooling of the planetary gear is therefore especially effective if the air-moving means is rotatable in two directions of rotation and generates an air stream in the same direction in both directions of rotation. The air flow direction is thus independent of the direction of rotation of the handheld power tool or of the air-moving means. The air-moving means may have blades for this purpose, whose blade faces are oriented perpendicular to the directions of rotation. It is especially advantageous for the blades to be embodied with at least two blade faces; one blade face, in a first direction of rotation, directs the air at least partly in an axial direction, and the other blade face, in a second direction of rotation opposite the first direction of rotation, directs the air at least partly in the same axial direction.

Good ventilation geometry together with high strength of the air-moving means can be attained if the air-moving means includes blades whose length in one direction of rotation is greater than their length in the axial direction.

In an advantageous refinement of the invention, the air-moving means generates an air stream directed in the radial direction and includes a deflection means for deflecting the air stream in the axial direction. It suffices here if the air stream is initially directed only at least partly in the radial direction. The deflection means is advantageously part of the air-moving means and is rotatable with it and can be formed as a chamfer on a wheel that holds the blades of the air-moving means together on their radially outer end.

Drawings

Further advantages will become apparent from the ensuing description of the drawings. In the drawings, exemplary embodiments of the invention are shown. The drawings, description and claims include numerous characteristics in

combination. One skilled in the art will expediently consider the characteristics individually as well and put them together to make useful further combinations.

Shown are:

Fig. 1, a fragmentary view of a cordless screwdriver with a housing shell removed;

Fig. 2, the removed housing shell of the cordless screwdriver from Fig. 1;

Fig. 3, an exploded view of a motor, a gear cover disk, an air-moving means, and a motor pinion;

Fig. 4, a sectional view through part of the cordless screwdriver of Fig. 1 and the elements of Fig. 3;

Fig. 5, a further air-moving means in the form of a fan wheel; and

Fig. 6, the fan wheel of Fig. 5 seen from the front.

Fig. 1 shows a handheld power tool in the form of a cordless screwdriver 2, with a tool receptacle 4 shown in suggested form, and with a housing that includes two housing shells 6 and one front housing element 8. One of the housing shells 6 is shown by itself in Fig. 2. Located inside the housing shells 6 is a motor 10, which is connected to a rear air-moving means, in the form of a fan wheel, that is not shown in the drawings. Upstream of the motor 10, looking from the tool receptacle 4, there is a planetary gear 12, which is shown in section in Fig. 4. In Fig. 1, what can be seen of the planetary gear 12 is a gear shifter 18, with an opening 16 serving as an air conduit.

The motor 10 includes a motor shaft 20 (Figs. 3 and 4), onto which a gear wheel in the from of a motor pinion 22 is thrust. The motor pinion 22 forms part of the planetary gear 12 and drives planet wheels 24, which roll along the inside of a ring gear 26. As a result, a sun wheel 28 is rotated, which in turn, via toothing 30,

drives further planet wheels 32, which roll in a second ring gear 34. The planet wheels 32 of the second gear stage drive a further sun wheel 36.

The planetary gear 12 is essentially closed off from the outside by a gear plate 39 in conjunction with the sun wheel 36, the gear sleeve 14, and a retaining disk 40. The retaining disk 40 is connected to the gear sleeve 14 via a form lock and brings about the rotational locking of the motor 10 in the gear sleeve 14 as well as axial spacing, by means of spacers 41, of the ring gear 26 of the first planetary gear stage.

Both between the sun wheel 36 and the gear plate 39 and in the retaining disk 40, openings 42, 44 are made for enabling an air stream through the planetary gear 12. This air stream is driven an air-moving means 46, which is designed as a fan wheel. The fan wheel is located predominantly inside the planetary gear 12 and is driven to rotate by the motor pinion 22 by means of a form lock with a neck 48 of the motor pinion 22. The fan wheel is located on the neck 48 by means of a clearance fit, in order to permit certain tolerances. In order to avoid an imbalance of the fan wheel despite these tolerances and even if there is a slight deviation from this clearance fit upon major acceleration of the air-moving means 46, the fan wheel is supported primarily directly on the motor shaft 20 in a concentric bearing seat 50 and is kept centered by the motor shaft 20. In the region of this bearing seat 50, the air-moving means 46 is located between the planetary gear 12 and a bearing 52 of the motor shaft 20. Outside this bearing seat 50, the fan wheel is located between the retaining disk 40 and the planet wheels 24, or in other words inside the planetary gear 12.

To maintain a spacing between the fan wheel and the planet wheels 24 and between the fan wheel and the ring gear 26, a runup disk 53 is located between the fan wheel and the planet wheels 24. Upon a rotation of the fan wheel, an air stream primarily in the radial direction 58 is generated by twelve blades 56 of the fan wheel that are oriented in the axial direction 54; this air stream is deflected at least partly in the axial direction 54, specifically in the direction toward the motor 10, by oblique faces 60, which are integrally formed onto a wheel 62 that holds the blades 56 together on the radially outer end of each of the blades. An air stream

moved in this way is forced through the openings 44 in the retaining disk 40 in the direction of the arrow 64 toward the motor 10 and along this motor. In its further course, this air stream is deflected out of ventilation openings 66 in the housing shells 6 and out of the handheld power tool.

Because of this air stream, an underpressure is generated inside the planetary gear 12, and by means of it air is aspirated through ventilation openings 68 in the housing shells 6. This air stream, through the openings 16 in the gear shifter 18, flows under the gear shifter 18 and through switching spring openings 70 in the gear sleeve 14, through the gear sleeve 14, into the interior of the planetary gear 12, as indicated by an arrow 72. This air stream can flow over the ring gears 26, 34 from outside and in this way cools the planetary gear 12. The handheld power tool 26 is supported inside the gear sleeve 14 by four supporting arms, which are not visible in the sectional view shown in Fig. 4. Instead, hollow chambers 74 between the supporting arms can be seen, through which the air stream can flow.

Because of the underpressure generated in the planetary gear 12 by the air-moving means 46, a further air stream, represented by an arrow 76, is steered out of the coupling region 38 through the openings 42 into the interior of the planetary gear 12. This air stream can flow directly around the planet wheels 24, 32 of both gear stages of the planetary gear 12 and thus effectively cool them.

Figs. 5 and 6, in a view from the back and the front, respectively, show a further air-moving means 78. This air- moving means 78, again designed as a fan wheel, can be connected in form-locking fashion to the motor pinion 22 by means of a clearance fit 80 shaped as a negative of the tooth form to fit the toothing of the motor pinion 22 and is carried along by the motor pinion in the tangential direction 82. In the rear and radially inner region, the air-moving means 78 includes a further fit 84 for being supported directly on the motor shaft 20. The air-moving means 78 includes eight blades 86, which each have one first and one second oblique, concave blade face 88, 90. In clockwise operation of the handheld power tool, the air stream is forced radially outward and axially rearward by the first blade face 88. The portion of the air stream forced radially outward is also forced to the rear in the axial direction 54 by a concave oblique face 92 of a

wheel 94 that connects the radially outer ends of the blades 86. In this way, in clockwise operation, an air flow directed inward is produced, which cools the planetary gear 12 as described above. In counterclockwise operation, the second blade face 90 forces the air stream radially outward and axially rearward, so that in an analogous way, an air stream to the rear - and thus because of the draft, an air stream through the planetary gear 12 - is generated.

List of Reference Numerals

2	Cordless screwdriver
4	Tool receptacle
6	Housing shell
8	Housing element
10	Motor
12	Planetary gear
14	Gear sleeve
16	Opening
18	Gear shifter
20	Motor shaft
22	Motor pinion
24	Planet wheel
26	Ring gear
28	Sun wheel
30	Toothing
32	Planet wheel
34	Ring gear
36	Sun wheel
38	Coupling region
39	Gear plate
40	Retaining disk
41	Spacer
42	Opening
44	Opening
46	Air-moving means
48	Neck
50	Bearing seat
52	Bearing
53	Runup disk
54	Axial direction
56	Blade

58 Radial direction
60 Oblique face
62 Wheel
64 Arrow
66 Ventilation opening
68 Ventilation opening
70 Switching spring opening
72 Arrow
74 Hollow chamber
76 Arrow
78 Air-moving means
80 Clearance fit
82 Tangential direction
84 Fit
86 Blade
88 Blade face
90 Blade face
92 Oblique face
94 Wheel